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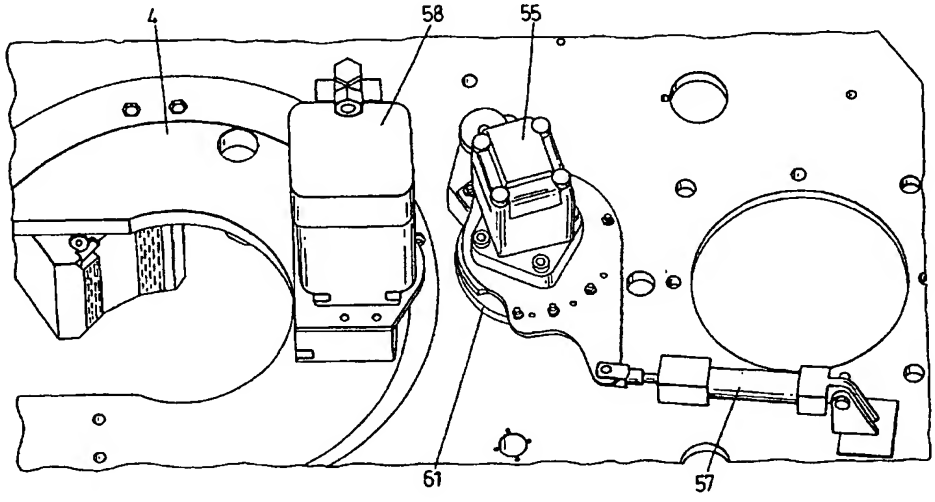
(54) Title: AN APPARATUS AND METHOD FOR FACILITATING THE CONNECTION OF PIPES



(57) Abstract: An apparatus for facilitating the connection of pipes comprises a rotary (4) and a stator (5), the rotary comprising at least one hydraulically actuated jaw (24,25,26), and a pump (58) arranged on the rotary (4) for pumping hydraulic fluid for actuation of the or each jaw (24,25,26), the stator comprising a motor (55) arranged on the stator (5), so that rotational energy can be transferred from the motor to the pump in an operational configuration.

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AN APPARATUS AND METHOD FOR FACILITATING THE CONNECTION OF PIPES

This invention relates to an apparatus and a method for facilitating the connection of pipes, and more particularly, but not exclusively, to a powered drill pipe tong for facilitating the connection of sections or stands of drill pipe.

Drill pipe tongs are commonly used for facilitating the connection of sections or stands of drill pipe to a pipe string. Typically, the pipe string hangs in a wellbore from a spider in a floor of an oil or gas rig.

A section or stand of drill pipe to be connected to the pipe string is swung in from a drill pipe rack to the well centre above the pipe string. A pipe handling arm may be used to guide the drill pipe to a position above the pipe string. A stabbing guide may then be used to align a threaded pin of the drill pipe with a threaded box of the pipe string. A drill pipe tong is then used to tighten the connection to a torque of typically 68,000Nm (50,000lb.ft).

The drill pipe tong is also used for disconnecting drill pipe. This operation involves breaking the connection which requires a torque typically greater than the tightening torque which may typically be used in the order of 110,000Nm (80,000lb.ft).

A drill pipe tong generally comprises jaws mounted in a rotary which is rotatably arranged in a housing. The jaws are moveable relative to the rotary in a generally radial direction towards and away from an upset part of the pipe to be gripped. The upset parts of the pipe are generally located above the pin and below the box of the pipe and have an enlarged outer diameter and/or a reduced inner diameter.

In use, the rotary is rotated forcing the jaws along cam surfaces towards the upset part of the section of pipe. Once the jaws fully engage the upset part, the rotary carries on rotating applying torque to the threads and hence tightens the connection between the section of pipe and the pipe string.

Several problems have been observed with such prior art drill pipe tongs.

In particular, such drill pipe tongs can badly scar the upset part of the pipe, particularly if the jaws start rotating relative to the drill pipe.

Once scarred, the pipe is then lowered into the wellbore. Friction between the wellbore (or casing lining the wellbore) and the scarred upset grinds the upset, reducing the diameter.

Scarring of the upset may also be caused by having to reapply the jaws. This is especially common when connecting pipe with "wedge threads" which requires approximately 80° of turn in order to torque the connection. Many prior art wrenching tongs need to be reapplied to the pipe every 25°.

A reduction in diameter of the upset requires the use of a drill pipe tong or for the old drill pipe tong to be modified therefor.

An attempt at solving this problem is disclosed in PCT publication Number WO 92/18744, which discloses a rotary comprising hydraulically operated active jaws and stationary passive jaws. The hydraulically activated jaws are engaged fully with the pipe prior to rotation of the rotary, thereby substantially reducing scarring. A hydraulic circuit is provided on the rotary for actuating the jaws. A plunger is used to activate the hydraulic system by depressing a hydraulic piston of the hydraulic circuit repeatedly. This operation takes time. If several

seconds can be saved per connection, the overall cost of the construction of an oil or gas well can be drastically reduced, as long as reliability is not sacrificed.

Another problem associated with the rotary disclosed in PCT Publication Number WO 92/18744 is that repeated depressing of the plunger for engaging the jaws fully with the pipe may itself cause some scarring.

A further problem associated with power tongs is how to move jaws into engagement with a tubular with sufficient force and sufficient speed.

A still further problem associated with a rotary for power tong is how to fit a mechanism for applying jaws to a tubular into the confined space of a rotary. In particular, the problem arises that if a pump is provided on the rotary for pumping hydraulic fluid, the means of supplying power to the pump must be disconnected before the rotary can be rotated to torque the connection between pipes. This further adds to the overall time of the operation.

If a pump is not provided on the rotary, the hydraulic pressure must be provided via a hose attached to the rotary, and this also must be disconnected before the rotary can be rotated.

Accordingly, a first aspect of the invention provides an apparatus for facilitating the connection of pipes, which apparatus comprises a rotary (4) and a stator (5), said rotary (4) comprising at least one jaw (24,25,26), at least one piston (15,16,17) arranged in at least one cylinder (18,19,20) for actuating said at least one jaw (24,25,26), and a hydraulic circuit (100) linking a first chamber in front of said piston (15,16,17) and a second chamber to a rear side of said piston (15,16,17) such that, in use, hydraulic fluid is expelled from one of said first

or second chambers and replenishes the other of said first and second chambers.

Other features of the first aspect of the invention are set out in claims 2 to 12.

There is also provided a method for facilitating the connection of pipes, comprising engaging a motor attached to a stator with a pump attached to a rotor and transferring rotational energy from the motor to the pump, enabling the pump to drive hydraulic fluid to actuate at least one jaw. In a preferred embodiment, the method comprises the step of moving the motor from a first position in which it is disengaged from the pump to a second position in which the motor and the pump are engaged to transfer rotational energy from the motor to the pump.

A second aspect of the invention provides an apparatus for facilitating the connection of pipes which apparatus comprises a rotary and a stator, said rotary comprising at least one jaw, at least one piston arranged in at least one cylinder for actuating said at least one jaw, and a hydraulic circuit linking a first chamber in front of said piston and a second chamber to a rear side of said piston such that, in use, hydraulic fluid is expelled from one of said first or second chambers and replenishes the other of said first or second chambers.

There is also provided a method for facilitating the connection of pipes, the method using the apparatus of the first aspect of the invention, the method comprising the step of expelling hydraulic fluid from one of said front or rear sides of said piston and replenishing the other of said front or rear sides of said piston.

A third aspect of the invention provides an apparatus for facilitating the connection of pipes which apparatus comprises a rotary and a stator, said rotary comprises at least one jaw and at least one piston arranged in at least

one cylinder for actuating said at least one jaw, and a hydraulic circuit, wherein said hydraulic circuit comprises a valve preventing return flow of hydraulic fluid and a restriction such that, in use, the arrangement allows a finite force to be applied to said pipe.

There is also provided a method for facilitating the connection of pipes, the method using the apparatus of the second aspect of the invention, the method comprising the step of allowing hydraulic fluid to leak from said hydraulic circuit such that said at least one jaw applies a finite force to said pipe.

For a better understanding of the invention, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 is a perspective view of an apparatus in accordance with the invention prior to use;

Figure 2 is a top plan view, partly in cross-section of part of the apparatus of Figure 1;

Figure 3A is a top plan view of the apparatus of Figure 1 in a first stage of operation;

Figure 3B is a perspective view of part of the apparatus of Figure 1 in a first stage of operation.

Figure 4A is a top plan view of the apparatus of Figure 1 in a second stage of operation;

Figure 4B is a perspective view of part of the apparatus of Figure 1 in a second stage of operation.

Figure 5 is a perspective view of a part of the apparatus of Figure 1;

Figure 6 is a perspective view of another part of the apparatus of Figure 1;

Figure 7 is a schematic diagram of a part hydraulic, part mechanical circuit used in the apparatus of Figure 1 in a first stage of operation;

Figure 8 is a schematic diagram of the part hydraulic, part mechanical circuit of Figure 7 in a second stage of operation;

Figure 9 is a schematic diagram of the part hydraulic, part mechanical circuit of Figure 7 in a third stage operation;

Figure 10 is a schematic diagram of the part hydraulic, part mechanical circuit of Figure 7 in a fourth stage of operation;

Figure 11 is a cross sectional view of an arrangement of part of the apparatus of Figure 1; and

Figure 12 is a cross sectional view of an alternative arrangement shown in Figure 12.

Referring to Figure 1 there is shown an apparatus which is generally identified by reference numeral 1.

The apparatus 1 comprises a drill pipe tong 2 and a backup unit 3.

The drill pipe tong 2 comprises a rotary 4 and a stator 5.

Referring to Figure 2, the rotary 4 comprises a housing 6 which is provided with a toothed ring 7 for engagement with toothed drive wheels in a stator 5 of the drill pipe tong 2. The housing 6 is also provided with an opening 8 for receiving a drill pipe.

Three piston and cylinders 9, 10 and 11 are arranged about the rotary 4 spaced at 120° to each other and are directed to the centre of the rotary 4. The piston and cylinders 9, 10 and 11 comprise static pistons 12, 13 and 14 each provided with a piston head 15, 16 and 17. Cylinders 18, 19 and 20 are slideable along said piston heads 15, 16 and 17 towards and away from the centre of the rotary 4. Sealing rings 21, 22 and 23 are provided in the piston heads 15, 16 and 17 between the piston heads 15, 16 and 17 and the cylinders 18, 19 and 20.

Cylinders 18, 19 and 20 are provided with jaws 24, 25 and 26 for engaging with the upset of a drill pipe. The jaws 24 and 25 are located in corresponding dovetail slots 27 and 28. The cylinder 20 is shown provided with an extension member 29 between the cylinder 20 and the jaws 26. The extension member 29 is located in dovetail slots 30 and the gripping elements 26 are located in corresponding dovetail slots 31 in the extension member 29. In use, either all of the cylinders 18, 19 and 20 are provided with extension members 29 or none of the cylinders 18, 19 and 20 are provided with extension members 29.

Hydraulic lines 32, 33 and 34 and hydraulic lines 35, 36 and 37 are arranged in each piston 12, 13 and 14 for the provision of hydraulic fluid in front of and behind the piston heads 15, 16 and 17.

Two release valves 38 and 39 are arranged on the housing 2. The release valves 38 and 39 are used for retracting cylinders 9, 10 and 11 and hence disengaging the gripping elements 24, 25 and 26 from a section of stand of drill pipe.

Referring to Figure 11, the rotor 4 has a cover plate 40 through which the release valves 38 and 39 can be accessed. The release valves 38 and 39 may be operated manually or operated by activating mechanisms, two suitable activating mechanisms are shown in Figures 11 and 12.

The release valves 38 and 39 are arranged on opposite sides of the rotary so that, when release of the gripping elements 24, 25 and 26 from the drill pipe is required, at least one will be under an activating ring 41, the activating ring 41 being broken across the opening 8. Six activating valves 42 are arranged about the activating ring 41 in lid 43 of the stator 5. Each activating valve 42 comprises a piston housing 44, a cylinder 45, a piston 46, a return spring 47 and a port 48. When it is desired to

activate the release valves 38 and/or 39, pneumatic or hydraulic fluid pressure is applied via a control panel (not shown) through port 48 into cylinder 45, displacing piston 46. The piston 46 pushes ring 41 on to plate 49 above release valve 39, and/or plate (not shown) above release valve 38. The plate 49 is retained at one end on a bolt shaft 50 to cover plate 40, and at the other end to a plunger 51 which is slideably arranged in a hole 52 in the cover plate 40. The plunger 51 is biased upwardly by a spring 53 located beneath a plate 54 which extends beyond the diameter of the hole 52. Upon displacement of the ring 41, the plate 49 pushes plunger 51 activating the release valve 39.

An alternative activating mechanism is shown in Figure 12. The rotor 4 comprises substantially the same arrangement, however the lid 43 comprises activating valves 42' which comprise a piston housing 44', a piston 46', a return spring 47' and a hose 48' arranged between the piston housing 44' and the piston 46'. The hose 48' links the activating valves 42' and leads to a pneumatic or hydraulic fluid supply (not shown). Upon an increase in pressure in the hose 48', the piston 46' is displaced, activating the release valve 39 in the same way as that described above with reference to Figure 11.

Referring now to Figure 3 and 4, there is shown a hydraulic motor 55 arranged on the lid 40 of the stator 5. The hydraulic motor 55 is moveably arranged at one end on a shaft 56 which is fixed to the lid 40 of the stator 5. A piston and cylinder 57 is fixed at one end to the stator 5, and at the other end to one side of the hydraulic motor 55. A hydraulic pump 58 is arranged on the rotor 4.

Figure 5 shows the hydraulic motor 55 provided with a mounting bracket 59 fixed to the static base thereof. The mounting bracket 59 is provided with a hole through which

drive shaft 60 projects. The drive shaft 60 has splines on to which a gear 61 is mounted. A disk 63 is mounted on a bearing 62 which is mounted on the drive shaft 60 below the gear 61. The gear 61 and disk 62 are retained on the drive shaft 60 by a c-clip 64. The mounting bracket 59 has two flanges, one provided with a hole for providing attachment means to the piston and cylinder 57, and the other provided with a lug 65 arranged substantially in parallel therewith which supports a hose 66 through which the shaft 56 is rotatably arranged. The end of the shaft 56 is fixed to the lid 40 of the stator 5.

Figure 6 shows the hydraulic pump 58 provided with a mounting bracket 67 fixed to the static base thereof. The mounting bracket 67 is provided with a hole through which a driveable shaft 68 projects. The driveable shaft 68 has splines on to which a gear 69 is mounted. A disk 70 is integral with and below the gear 69 driveable shaft 68. The gear 69 and disk 70 are retained on the driveable shaft 68 by a cap 71.

Referring back to Figure 3A, and 3B the gear 61 of the hydraulic motor 55 is out of engagement with the gear 69 of the hydraulic pump 58. The piston and cylinder 57 is retracted.

Referring back to Figure 4, the gear 61 of the hydraulic motor 55 is meshing with the gear 69 of the hydraulic pump 58. The piston and cylinder 57 has been operated by pneumatic or hydraulic fluid in to an extended position and has moved the hydraulic motor 55 towards the hydraulic pump 58.

The outer diameter of the disk 63 is of slightly smaller diameter then the gear 61, as is the corresponding disk 70 of the hydraulic pump 58. This controls the depth to which the teeth of the gears 61 and 69 can engage. This improves overall efficiency and reliability. It will be

appreciated that disks of any diameter may suffice, as long as they maintain the distance between gears.

Referring now to Figures 7 to 10 there is shown a schematic of the part hydraulic, part mechanical circuit of the apparatus of Figure 1 at various stages of operation. The circuit is generally identified by reference numeral 100.

The circuit 100 comprises a hydraulic pump 58 which is driveable by hydraulic motor 55. The circuit 100 also comprises piston and cylinders 9, 10 and 11 for engaging a tubular, two accumulators 101 and 102 for storing a charge for disengaging the cylinders from engagement with a tubular, a hydraulic circuit 103 and release valves 38 and 39.

In use, initially the hydraulic circuit 103 is not pressurised. The opening 8 of the rotor 4 is in line with the opening 8' of the stator. The hydraulic pump 58 is now situated opposite the opening 8, 8' at the rear of stator 5. The hydraulic motor 55 is in a retracted position (Figure 3).

When it is desired to use the drill pipe tong, the tong is placed around a box of a stand of tubulars which is to be connected to a string of tubulars, through opening 8, 8'. The piston and cylinder 57 is actuated, extending the piston from the cylinder which moves the hydraulic motor 55 towards the hydraulic pump 58. The gear 61 of the hydraulic motor 55 meshes with the gear 69 of the hydraulic pump 58. The hydraulic motor 55 is driven by an external hydraulic fluid supply (not shown) on the rig floor (Figure 4).

The hydraulic motor 55 drives the hydraulic pump 58 which pumps hydraulic fluid from a tank 104 (shown schematically as a separate tank, although is preferably a single tank) through a line 105 into a continuation of line

105 in a block 106. The hydraulic fluid flows past check valves 107 an 108. Pressure increases in the cylinders 18, 19 and 20 in front of the pistons 15, 16 and 17, which moves the cylinders 18, 19 and 20 into engagement with the box of the tubular to be gripped. Simultaneously, hydraulic fluid flows past check valve 108 into accumulators 101 and 102. Pneumatic pressure in the accumulators builds up to a predetermined level such as 150 Bar, at which point a preset valve 109 closes and prevents further pressure build up in the accumulators 101 and 102 (Figure 8). At this point, hydraulic fluid only flows into the cylinders 18, 19 and 20. Hydraulic fluid behind the pistons 15, 16 and 17 is expelled through lines 110, 111 and 112, through flow divider 113, through lines 114, 115 into line 116, into common line 117, through line 118a valve 118b into the cylinders 18, 19 and 20 in front of the pistons 15, 16 and 17. It should be noted that fluid from behind the piston flows to the front of the piston, thereby only requiring a small amount of fluid to be drawn from the tank 104. A flow restrictor 118 inhibits egress of fluid out into tank 104 until the jaws are in firm engagement with the box of the stand of tubulars at which point hydraulic fluid leaks through a flow restrictor 118 and into tank 104 via connection 119, thus inhibiting over engaging the jaws 24, 25 and 26. A hydraulic lock on the front of the pistons 15, 16 and 17 inhibits the jaws 24, 25 and 26 from disengaging during rotation.

The flow divider 113 comprises three rotors 121, 122 and 123 arranged on a common shaft 24. When hydraulic fluid flows across the rotors 121, 122 and 123, the rotors allow equal volumes of fluid to pass, thereby ensuring even movement of the jaws 24, 25 and 26 arranged on the cylinders 18, 19 and 20.

Flow restrictor 118 allows fluid to flow therethrough slowly. This inhibits sudden movement of the cylinders 18, 19 and 20.

When a predetermined setting pressure is reached, an indicator 125 moves. This occurs due to valve 126 being set to open at a predetermined pressure, such as 280 Bar. This allows hydraulic fluid to flow through line 127 at a pressure above 280 Bar, say at 7 Bar. If the indicator 125 needs more than 5 Bar pressure to move, the indicator 125 will now move into an extended position, as shown in Figure 8. Hydraulic fluid at greater pressure is expelled in to the tank 104.

The hydraulic motor 55 is now swung about shaft 56 by activating piston and cylinder 57 (Figure 9). Gears 61 and 69 are now out of engagement. The rotor 4 is now rotated relative to the stator 5 to tighten the screw connection between tubulars to a predetermined torque. In this state, the cylinders 18, 19 and 20 are held engaged against the tubular by hydraulic fluid being prevented from escaping by check valve 107, and release valves 38 and 39 being in a closed position.

Fluid is retained in the accumulators 101 and 102 by check valve 108, and a check valve 126 which is maintained in a closed position by hydraulic fluid at greater pressure and by check valve 127 if the pressure is lower on the opposing side of check valve 126.

A particular advantage of the system described is the fact that an external power source can be used to drive the hydraulic motor 55, and this does not need disconnecting before the motor 4 is rotated because it is a simple matter to engage and disengage the motor 55 and the pump 58.

Once the rotor 4 stops rotating, the jaws 24, 25 and 26 may be disengaged form the tubular. This is carried out by pneumatic or hydraulic fluid being pressurised in

activating valves 42 which activates release valves 38 and 39, as described above with reference to Figures 11 and 12. This releases high pressure hydraulic fluid in control line 128 hence, a reduced pressure occurs on one side of a logic valve 129. The logic valve 129 shifts from a closed to an open position which allows high pressure hydraulic fluid to flow from in front of the pistons 15, 16 and 17 through line 130.

The logic valve 131 also shifts from a closed position to an open position as high pressure hydraulic fluid in line 132 and a reduced pressure occurs in line 128 on the opposing side of the logic valve 131, allowing high pressure fluid from the accumulators 101 and 102 to flow through the logic valve 131, through a restrictor 133. The high pressure hydraulic fluid from the accumulators 101, 102, opens slide valve 134 and passes therethrough, into line 117, through flow divider 113 and into cylinders 18, 19 and 20 behind pistons 15, 16 and 17. The jaws 24, 25 and 26 are hence disengaged from the tubular and retracted therefrom.

It should be noted that hydraulic fluid passes out from in front of the pistons 15, 16 and 17 into the line 130, through logic valve 129, through restrictor 135, through slide switch 134, into line 117, through flow divider 113 into the cylinders 18, 19 and 20 behind the pistons 15, 16 and 17. In this way, only an amount of hydraulic fluid equal to the difference in volumes between the volume in front of the pistons 15, 16 and 17 when in the fully extended position and the volume behind the pistons 15, 16 and 17 when in the fully retracted position is required to be held in the tank 104. This excess fluid flows through connection 119 and into tank 104.

It is also envisaged that the apparatus could be used with thin walled pipe, as it is relatively simple to alter

the force applied to the pipe by the jaws. The invention will also be applicable for any tubular or pipe such as casing, tool strings and drill pipes.

It is also envisaged that the accumulator could take the form of a spring or a battery.

It will be appreciated that although the engagement mechanism described comprises gears 61, 69 arranged on the motor 55 and pump 58 respectively any suitable engagement mechanism can be used. For example, a clutch or friction drive could be employed to engage and disengage the motor from the pump. However, a particular advantage of gears 61, 69 rotating in the same place as the rotor 4 is that if the motor 55 is not disengaged from the pump 58 before the rotor 4 is rotated, the components avoid serious damage.

CLAIMS:

1. An apparatus for facilitating the connection of pipes and comprising a rotary (4) and a stator (5), the rotary comprising at least one hydraulically actuated jaw (24,25,26), and a pump (58) arranged on the rotary (4) for pumping hydraulic fluid for actuation of the or each jaw (24,25,26), the stator comprising a motor (55) arranged on the stator (5), so that rotational energy can be transferred from the motor to the pump in an operational configuration.

2. An apparatus as claimed in claim 1, wherein the motor (55) comprises driving means (61) and the pump comprises pump driving means (69), the driving means (61) and pump driving means (69) being engageable, the driving means (61) and the pump driving means (69) being rotatable in the same plane as the rotary (4).

3. An apparatus as claimed in claim 2, wherein the motor (55) is rotatably arranged on the stator (4) via a shaft (56) so that the motor (61) can be moved in and out of engagement with the pump (69) by rotating the motor (55) around the shaft (56).

4. An apparatus as claimed in claim 2 or 3, wherein a piston and cylinder (57) is fixed at one end to the stator (4), and at the other end to the motor (55) for moving the motor to bring the driving means (61) and the pump driving means (69) in and out of engagement.

5. An apparatus as claimed in any preceding claim, wherein the motor (55) comprises a first gear (61) and the pump (58) comprises a second gear (69), the first gear and

second gear being engageable to transfer said rotational energy.

6. An apparatus as claimed in claim 5, wherein the first gear (61) is mounted on a drive shaft (60) and the second gear (69) is mounted on a driveable shaft, and wherein a first disc (63) is mounted on the drive shaft and a second disc (70) is mounted on the driveable shaft so that, when the first gear and second gear engage, the first disc contacts the second disc so as to control the depth to which the teeth of the first gear and the second gear mesh with each other.

7. An apparatus as claimed in any preceding claim, wherein the rotary (4) comprises at least one piston (15,16,17) arranged in a cylinder (18,19,20) for actuating said at least one jaw (24,25,26), and a hydraulic circuit (100) linking a first chamber in front of said piston (15,16,17) and a second chamber to a rear side of said piston (15,16,17) such that, in use, hydraulic fluid is expelled from one of said first or second chambers and replenishes the other of said first and second chambers.

8. An apparatus as claimed in claim 7, comprising at least two pistons (15,16,17), each arranged in a respective cylinder (18,19,20).

9. An apparatus as claimed in claim 8, further comprising a flow divider (113).

10. An apparatus as claimed in claim 7, 8 or 9, further comprising a tank (104) for holding hydraulic fluid.

11. An apparatus as claimed in claim 7, 8, 9 or 10, further comprising at least one accumulator (101,102) for holding a charge for release of the jaw from engagement with a pipe.

12. An apparatus as claimed in any preceding claim, wherein the rotary (4) comprises at least one piston (15,16,17) arranged in a cylinder (18,19,20) for actuating said at least one jaw (24,25,26), and a hydraulic circuit (100), wherein said hydraulic circuit (100) comprises a valve preventing return flow of hydraulic fluid (107) and a restriction (118) such that, in use, the arrangement allows a finite force to be applied to said pipe.

13. A method for facilitating the connection of pipes, comprising engaging a motor attached to a stator with a pump attached to a rotor and transferring rotational energy from the motor to the pump, enabling the pump to drive hydraulic fluid to actuate at least one jaw.

14. A method as claimed in claim 13, comprising the step of moving the motor from a first position in which it is disengaged from the pump to a second position in which the motor and the pump are engaged to transfer rotational energy from the motor to the pump.

15. A method for facilitating the connection of pipes comprising expelling hydraulic fluid from one of the front or rear sides of at least one piston arranged in a cylinder to actuate at least one jaw for gripping the pipe, and replenishing the other of said front or rear sides of said piston.

16. A method for facilitating the connection of pipes comprising driving hydraulic fluid around a hydraulic circuit to actuate at least one piston arranged in a cylinder to actuate at least one jaw for gripping the pipe, and allowing hydraulic fluid to leak from said hydraulic circuit such that said at least one jaw applies a finite force to said pipe.

17. An apparatus for facilitating the connection of pipes, which apparatus comprises a rotary (4) and a stator (5), said rotary (4) comprising at least one jaw (24,25,26), at least one piston (15,16,17) arranged in at least one cylinder (18,19,20) for actuating said at least one jaw (24,25,26), and a hydraulic circuit (100) linking a first chamber in front of said piston (15,16,17) and a second chamber to a rear side of said piston (15,16,17) such that, in use, hydraulic fluid is expelled from one of said first or second chambers and replenishes the other of said first and second chambers.

18. An apparatus for facilitating the connection of pipes which apparatus comprises a rotary (4) and a stator (5), said rotary (4) comprising at least one jaw (24,25,26) and at least one piston (15,16,17) arranged in at least one cylinder (18,19,20) for actuating said at least one jaw (24,25,26), and a hydraulic circuit (100), wherein said hydraulic circuit (100) comprises a valve preventing return of hydraulic fluid (107) and a restriction (118) such that, in use, the arrangement allows a finite force to be applied to said pipe.

19. A method for facilitating the connection of pipes, the method using the apparatus as claimed in claim 18, the method comprising the step of allowing hydraulic fluid to

leak from said hydraulic circuit (100) such that said at least one jaw (24,25,26) applies a finite force to said pipe.

20. A method for facilitating the connection of pipes, the method using the apparatus as claimed in any of claims 7 to 11 or 17, the method comprising the step of expelling hydraulic fluid from one of said front or rear sides of said piston and replenishing the other of said front or rear sides of said piston.

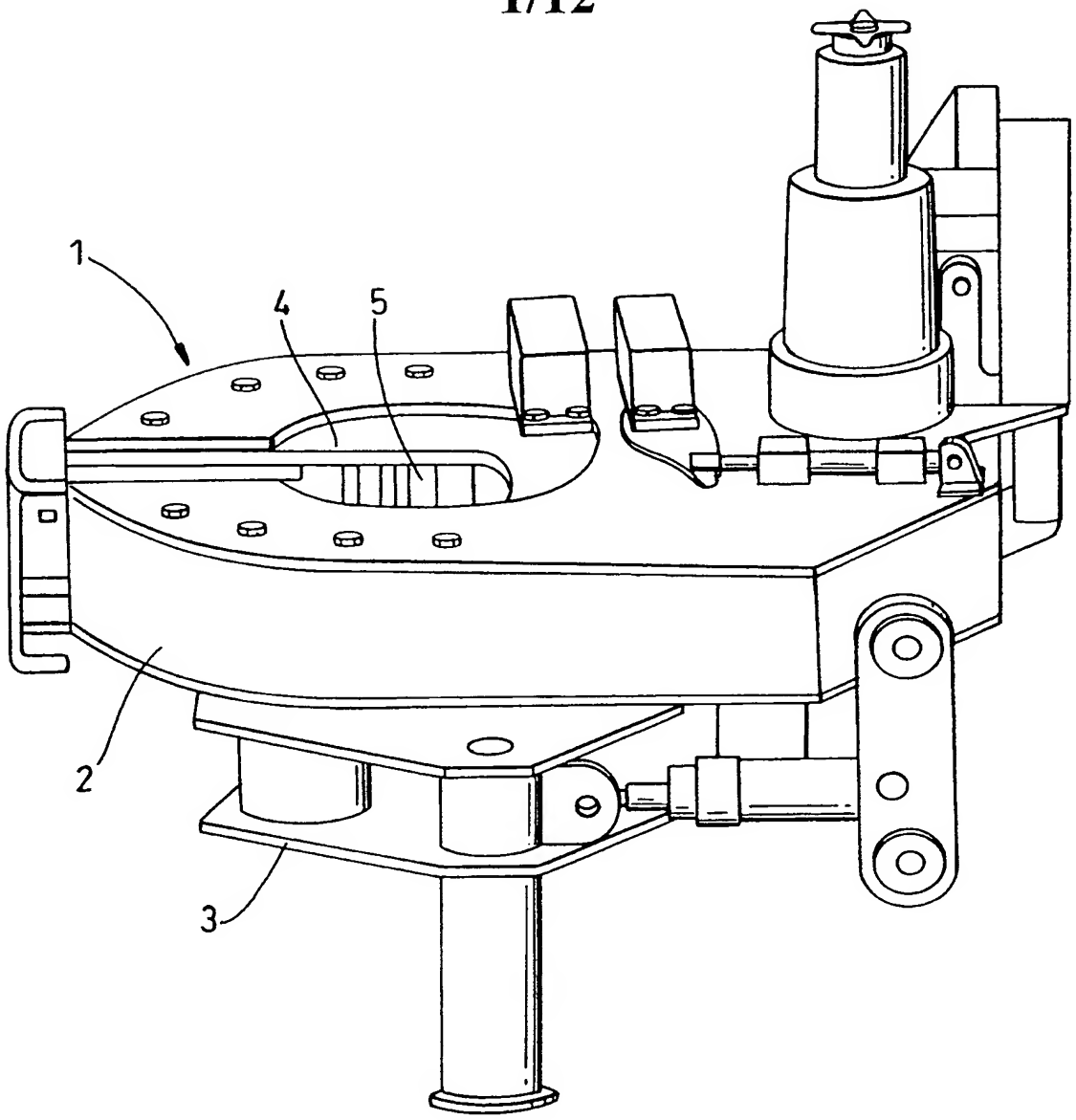

Fig. 1

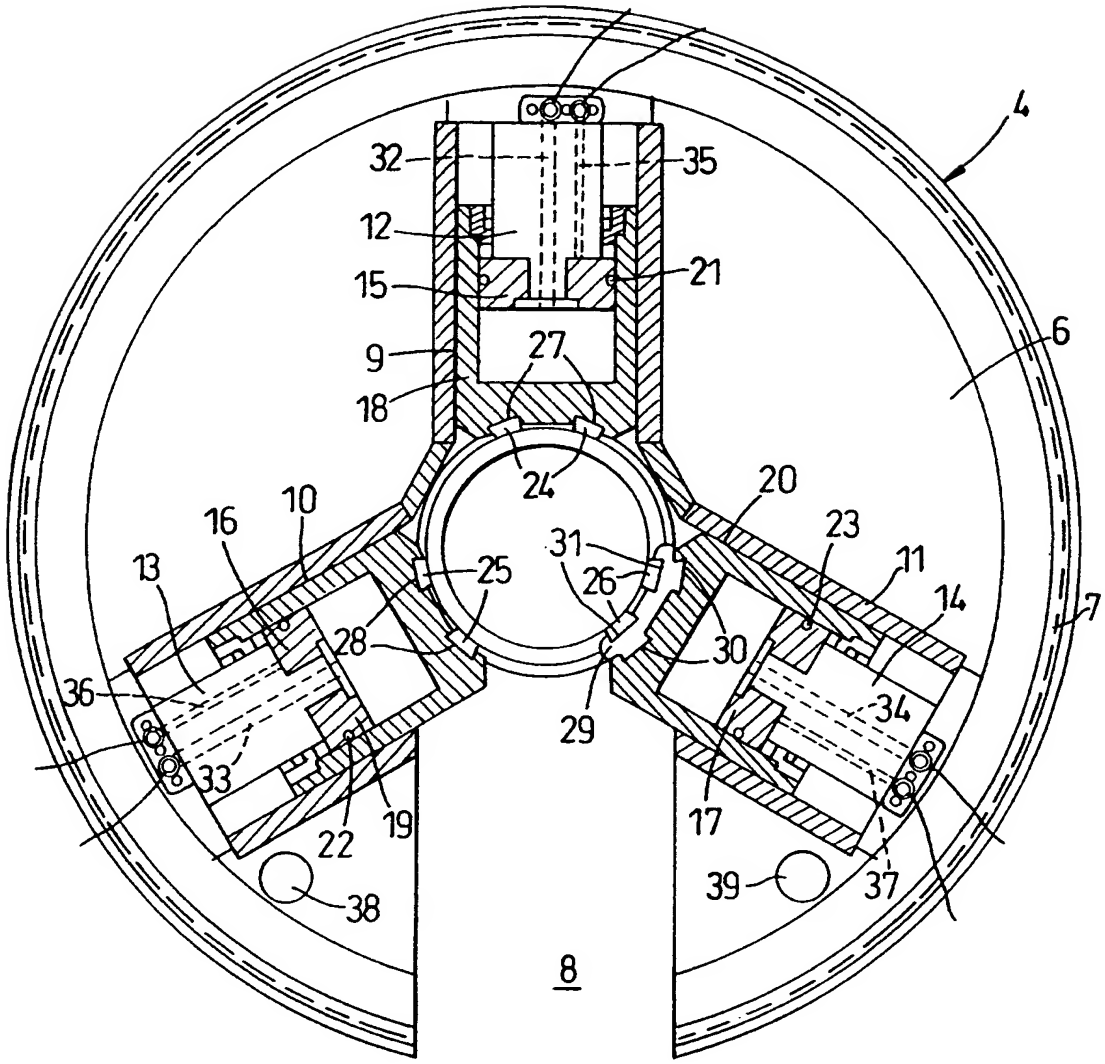
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Fig. 2

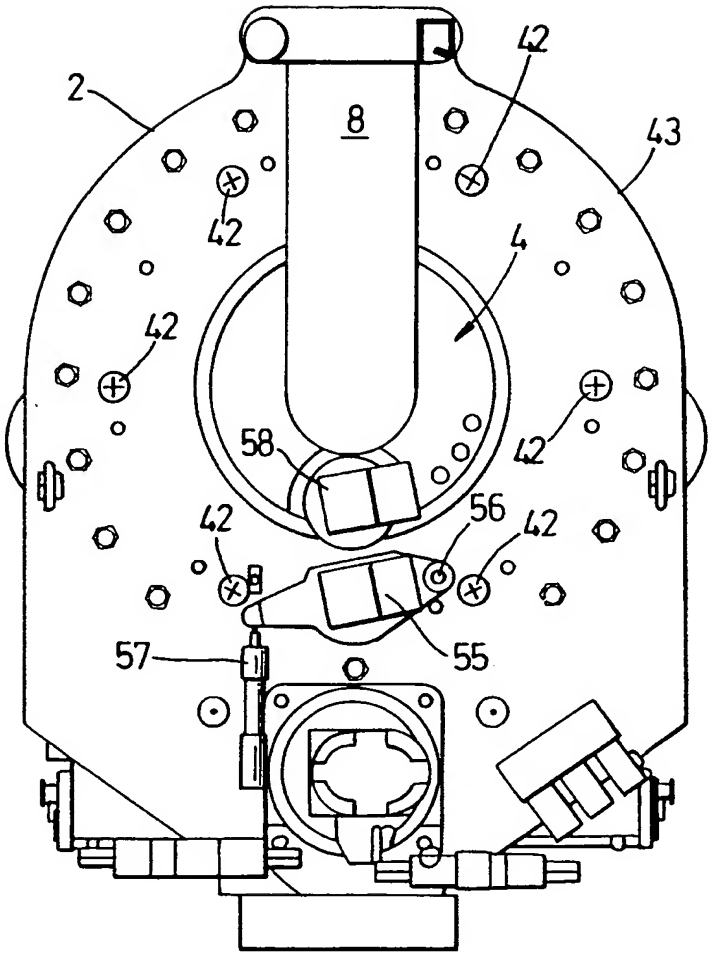

Fig. 3A

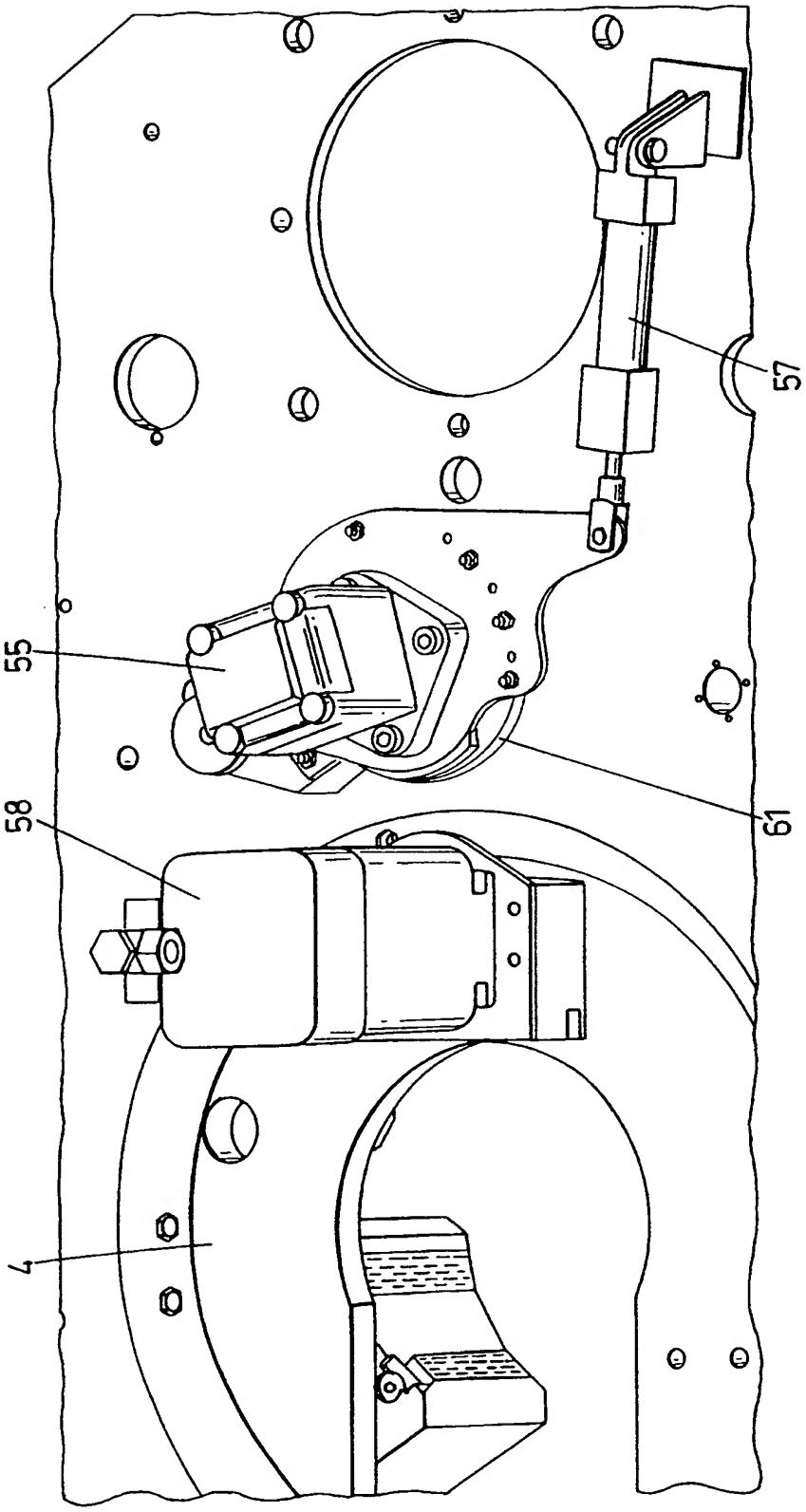

Fig. 3B

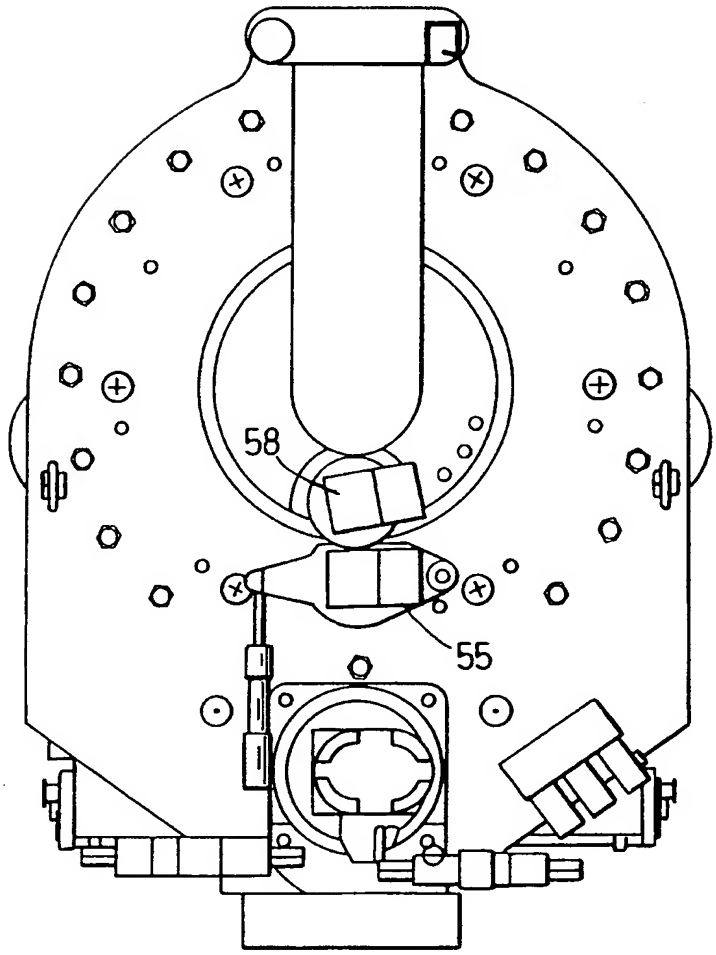

Fig. 4A

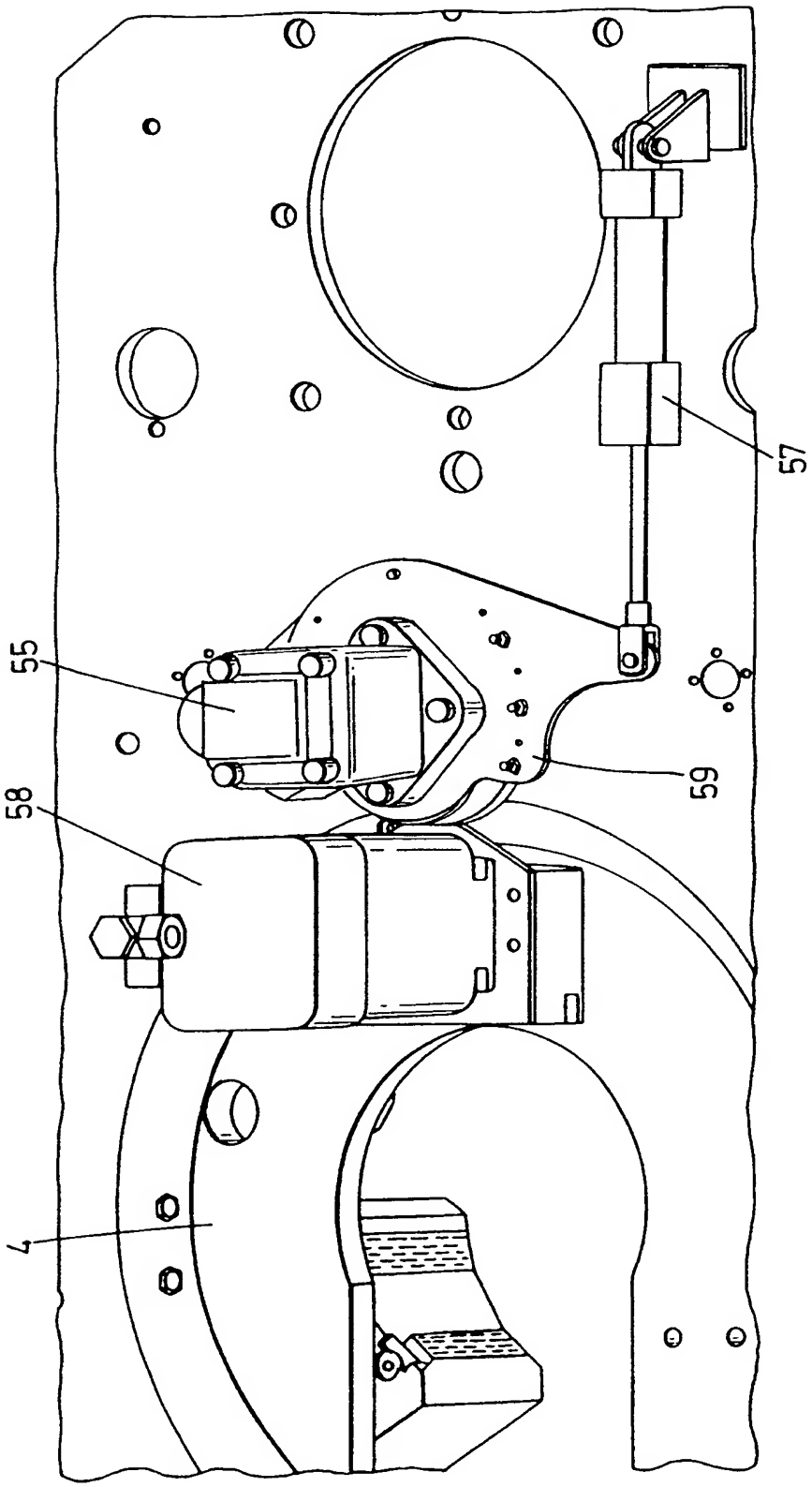

Fig. 4B

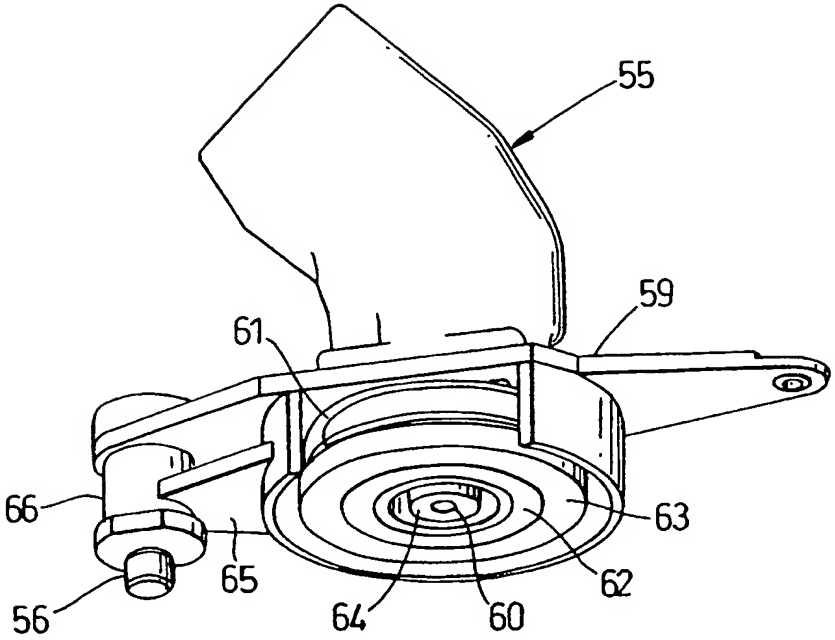

Fig. 5

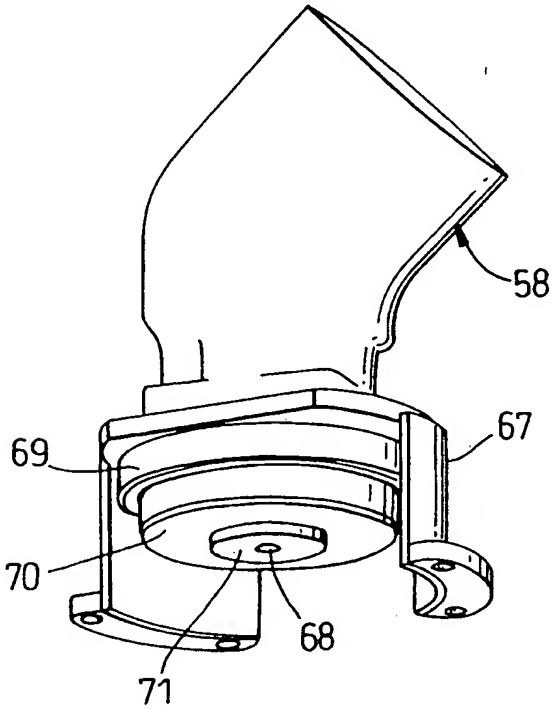

Fig. 6

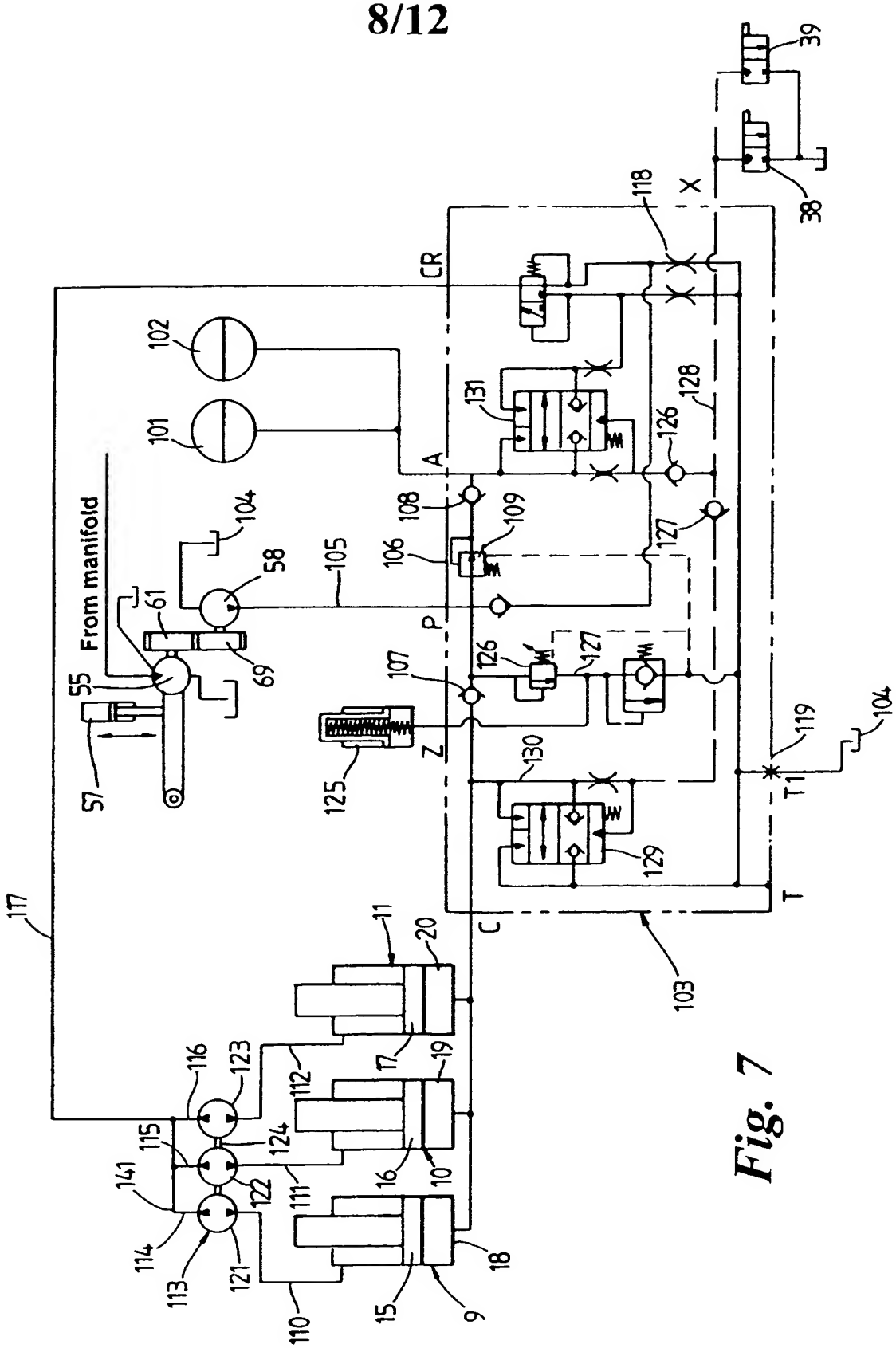
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Fig. 7

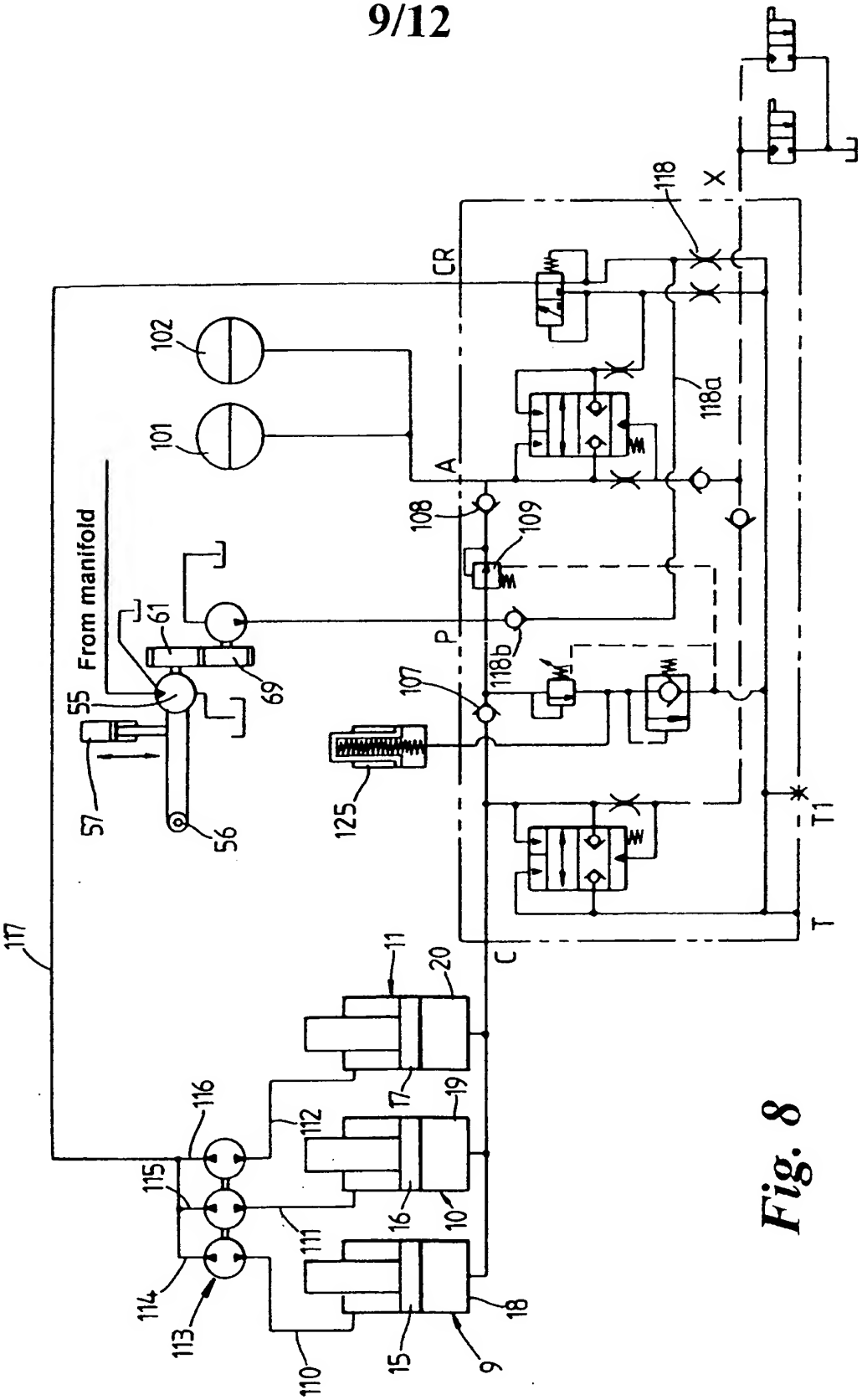
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Fig. 8

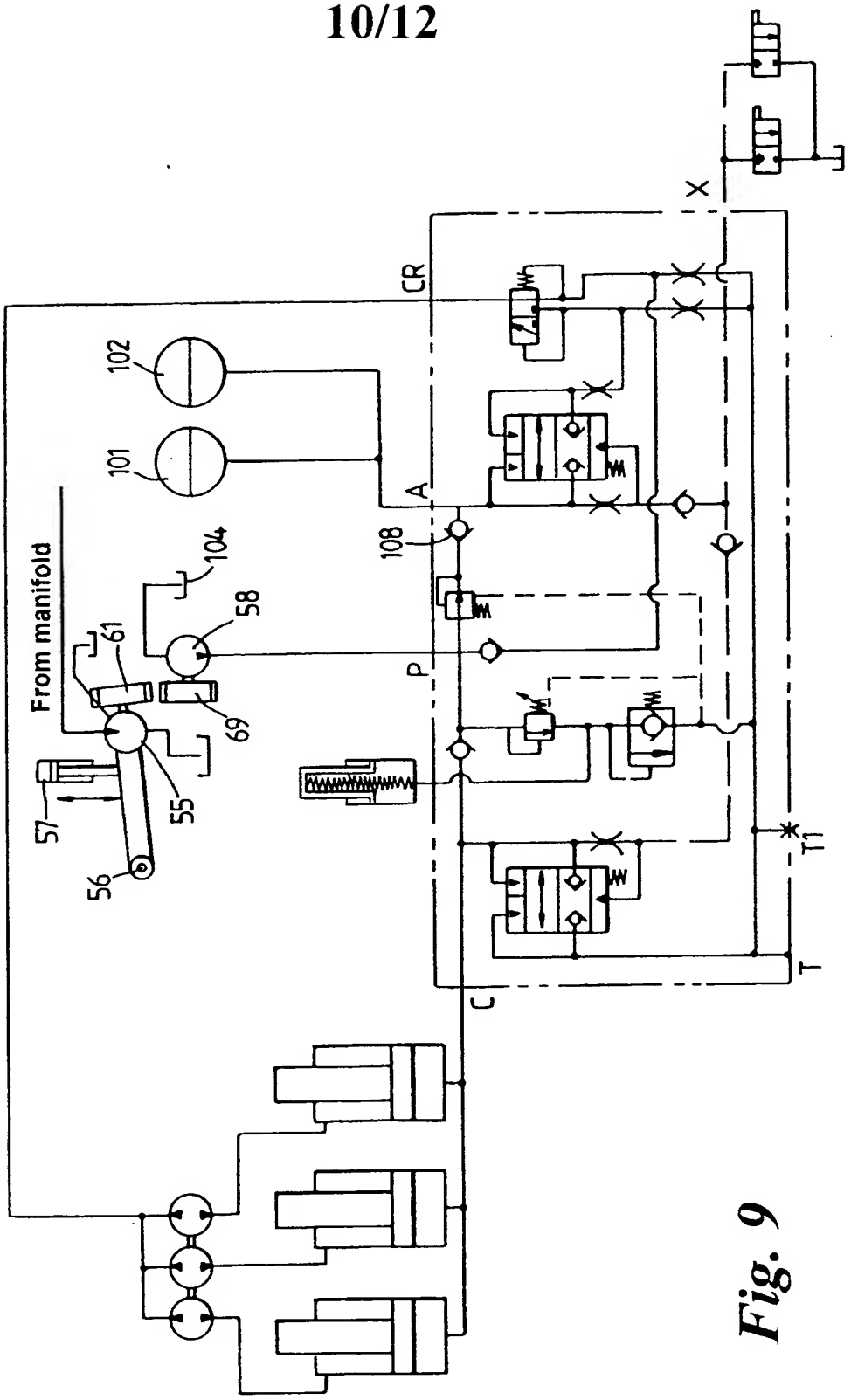

Fig. 9

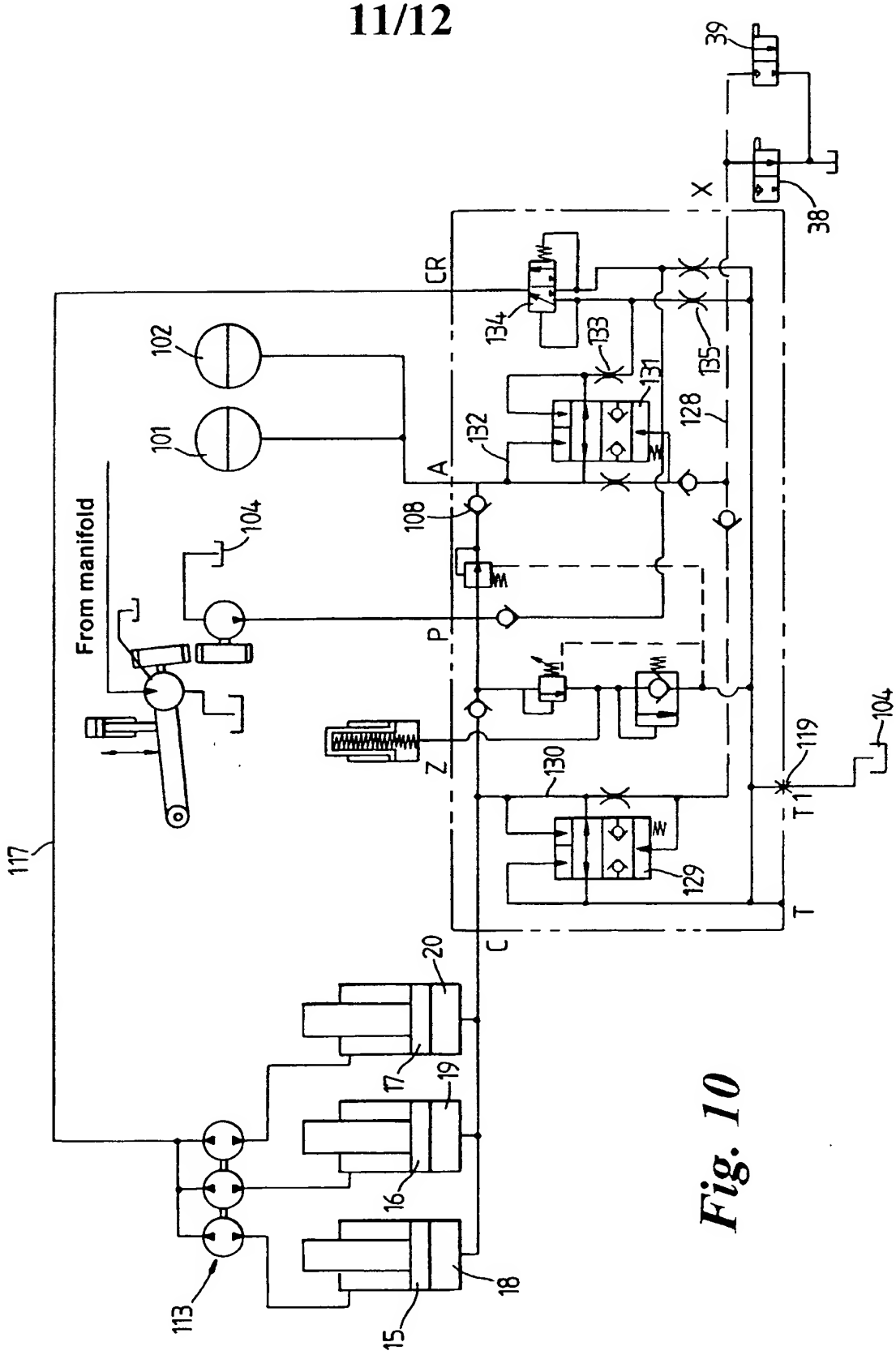
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Fig. 10

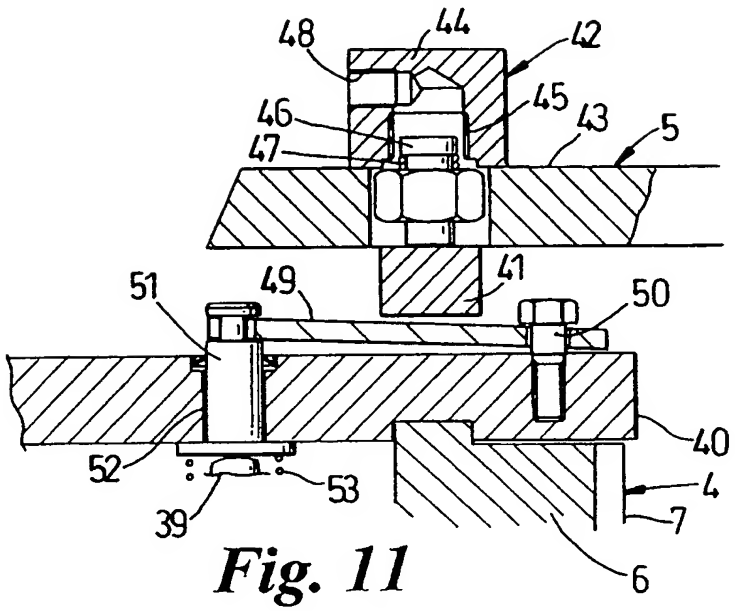
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Fig. 11

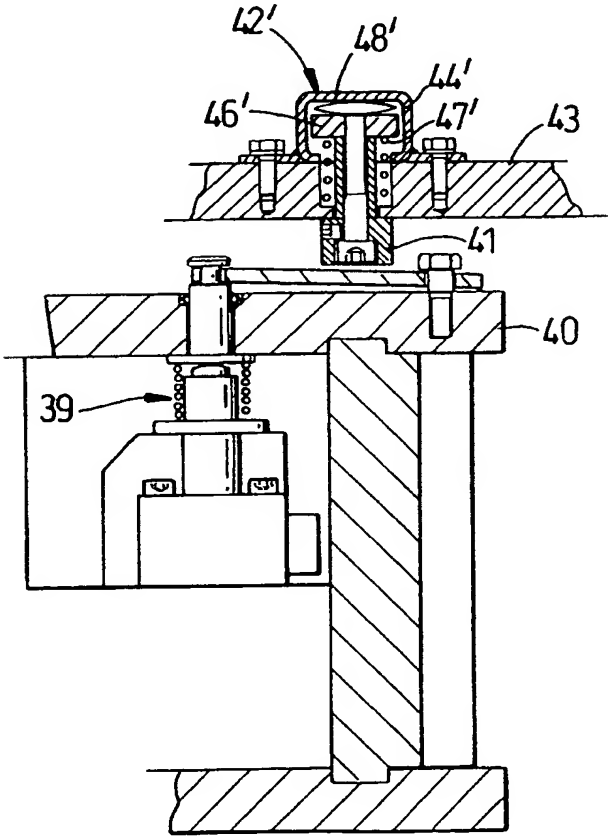
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Fig. 12

INTERNATIONAL SEARCH REPORT

Inter ›nal Application No
PCT/GB 00/02723

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E21B19/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 95 20471 A (CANRIG DRILLING TECH LTD) 3 August 1995 (1995-08-03) page 3, line 5 -page 4, line 7; figures abstract	1,2, 7-11,13, 15,17,20
X Y	EP 0 339 005 A (MARITIME HYDRAULICS AS) 25 October 1989 (1989-10-25) column 3, line 36 - line 62; figures column 4, line 12 - line 45 column 5, line 46 -column 6, line 21	1,7-10, 13,15, 17,20 12,16, 18,19
Y	US 4 712 284 A (COYLE SR WILLIAM E ET AL) 15 December 1987 (1987-12-15) column 1, line 5 - line 44 column 2, line 36 - line 65; figures	12,16, 18,19

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 October 2000	17/10/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Weiand, T

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INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/GB 00/02723

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
E	GB 2 346 576 A (WEATHERFORD LAMB) 16 August 2000 (2000-08-16) abstract; figures	15,17
E	GB 2 346 577 A (WEATHERFORD LAMB) 16 August 2000 (2000-08-16) abstract; figures	15,17
A	US 3 021 739 A (GRUNDMAN) 20 February 1962 (1962-02-20) claims; figures	1
A	GB 2 049 518 A (ECKEL MFG CO) 31 December 1980 (1980-12-31) figure 3	1

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 00/02723

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